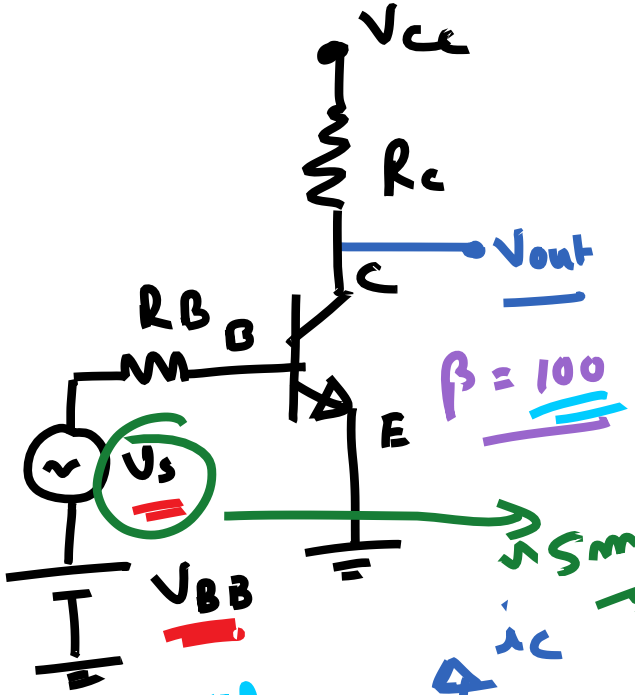
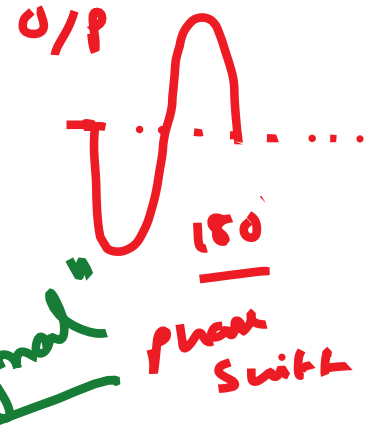
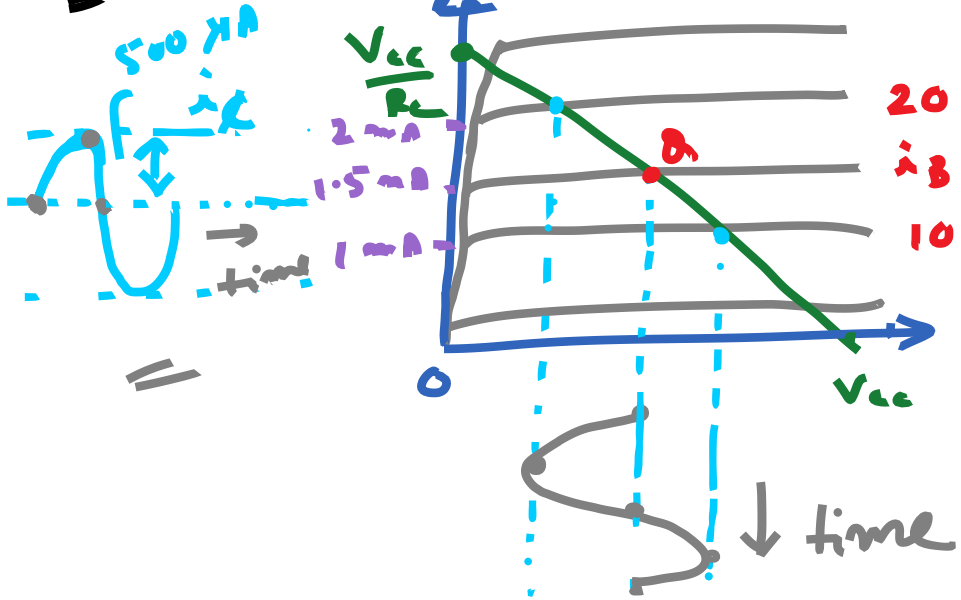
Basic BJT Amplifiers





Voltage Transfer characteristics (VTC)

VTC



output ch

ib, ic same phase

i/p and o/p 180° phase shift.

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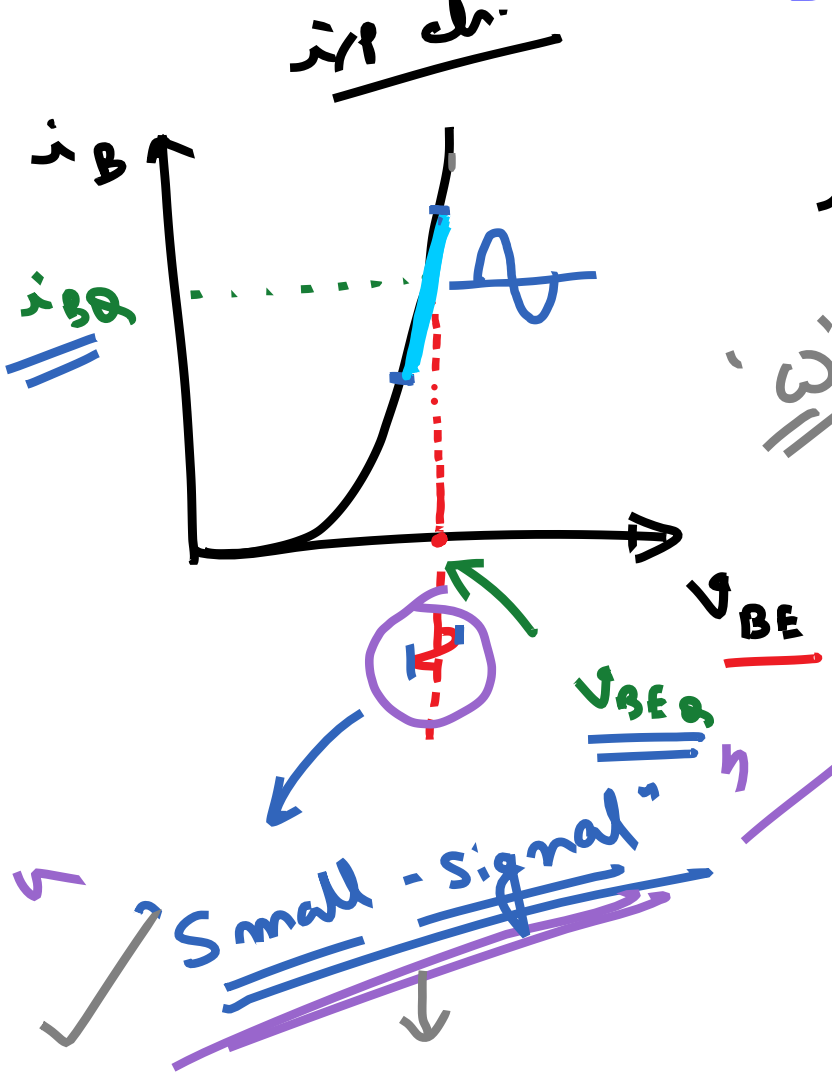
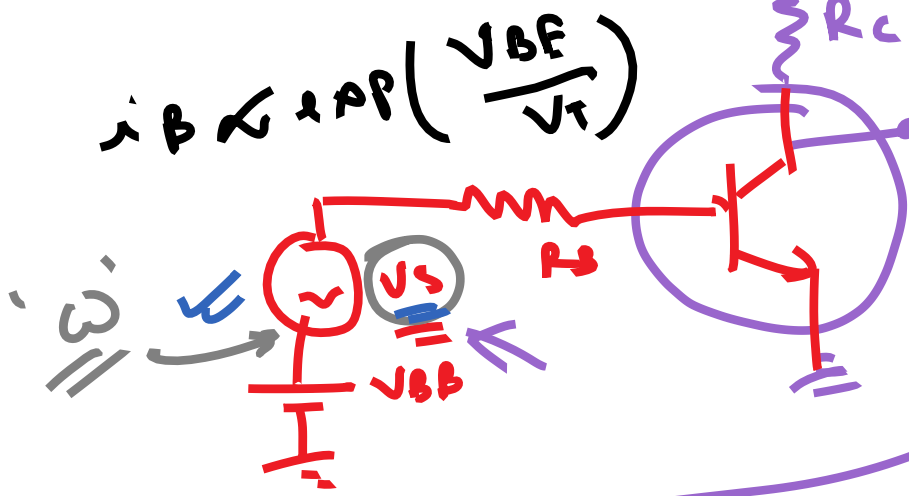


$i_B \propto \exp\left(\frac{v_{BE}}{V_T}\right)$



ω, 2ω, 3ω, ... Harmonic Distortion

linear n/w.

i_B linearly related with v_{BE} (i/p)

i_C

$v_{out} = v_{CE}$

i_B, i_C, v_{BE} → total value (Dc + Ac)

I_B, I_C, V_{BE} → DC value

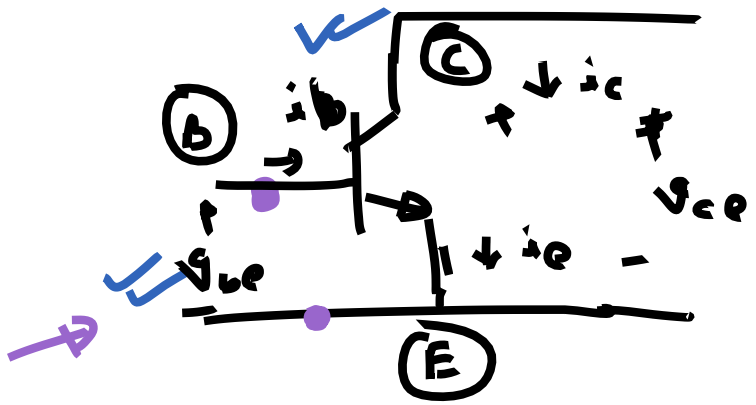
i_b, i_c, v_{be} → AC value

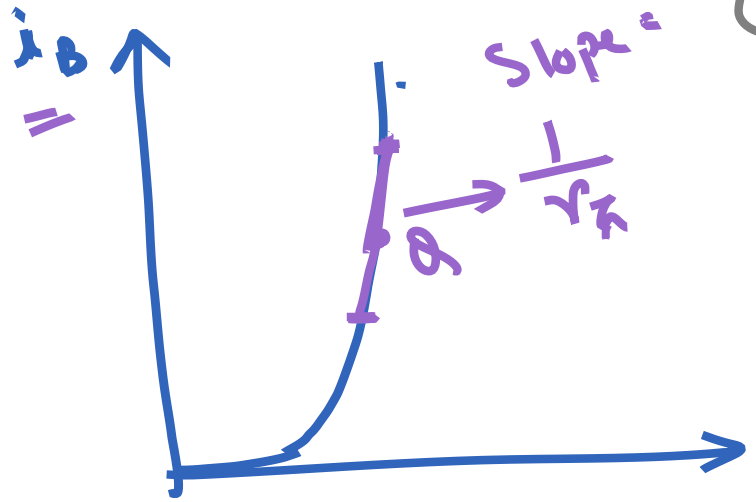
Basic BJT Amplifiers

$$i_C = I_S \exp\left(\frac{v_{BE}}{V_T}\right)$$

$$i_B = \frac{I_S}{\beta} \exp\left(\frac{v_{BE}}{V_T}\right)$$

Small-signal equivalent circuit of BJT:



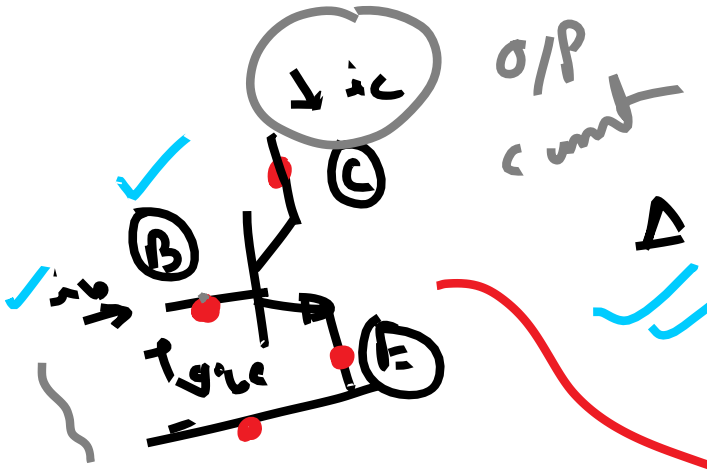


$$\frac{1}{r_\pi} = \left.\frac{\partial i_B}{\partial v_{BE}}\right|_{Q\text{-point}} = \frac{I_S}{\beta V_T} \exp\left(\frac{v_{BE}}{V_T}\right) = \frac{I_{BQ}}{V_T} = \frac{I_{CQ}}{\beta V_T}$$

$$\boxed{r_\pi = \frac{\beta V_T}{I_{CQ}}}$$

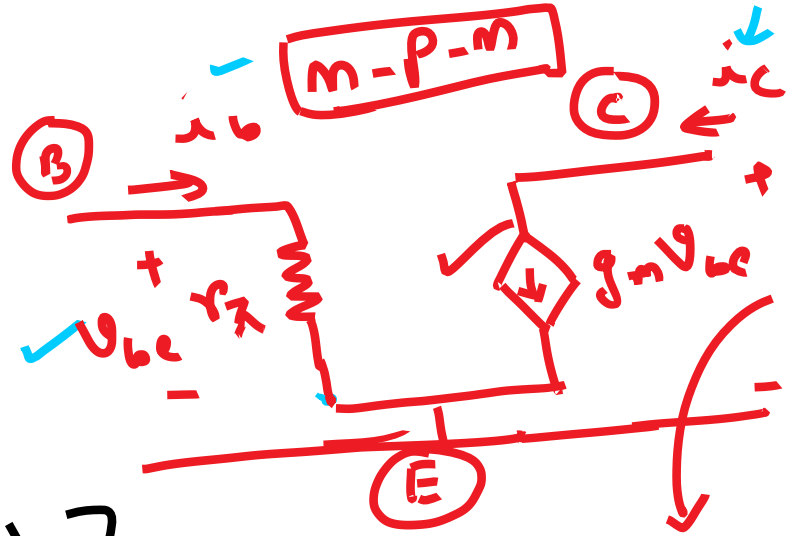
Diffusion resistance / base-emitter i/p resistance

Basic BJT Amplifiers



$$\Delta i_c = \frac{\partial i_c}{\partial v_{BE}}\bigg|_{Q\text{-point}} \Delta v_{BE}$$

$\frac{\partial i_c}{\partial v_{BE}}\big|_{Q\text{-point}}$ → g_m

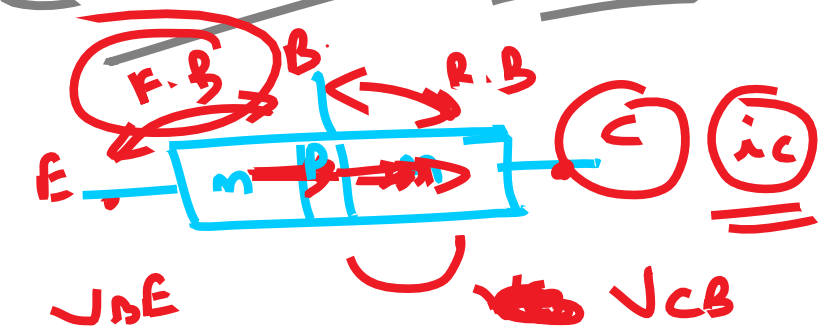


v_{be} → i/p voltage

$$\frac{\partial i_c}{\partial v_{BE}}\bigg|_{Q\text{-point}} = \frac{\partial}{\partial v_{BE}}\left[I_S \exp\left(\frac{v_{BE}}{V_T}\right)\right]$$

$$= \frac{I_S}{V_T}\exp\left(\frac{v_{BE}}{V_T}\right) = \frac{I_{CQ}}{V_T} = g_m$$

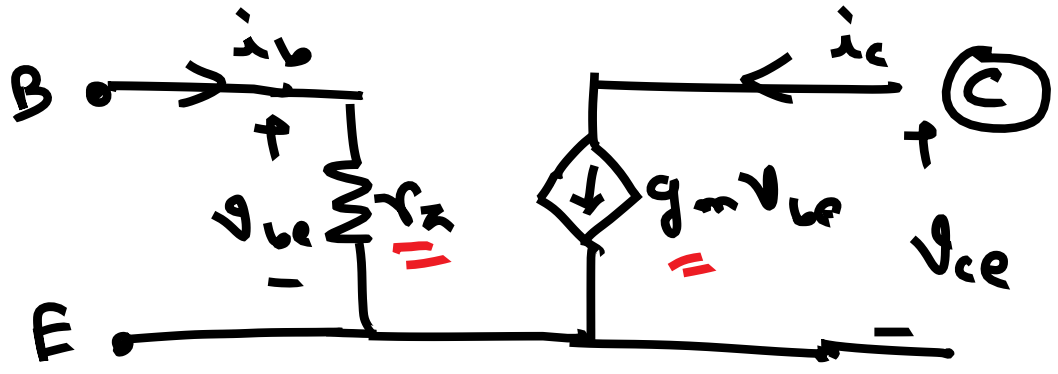
Trans-Conductance (g_m)

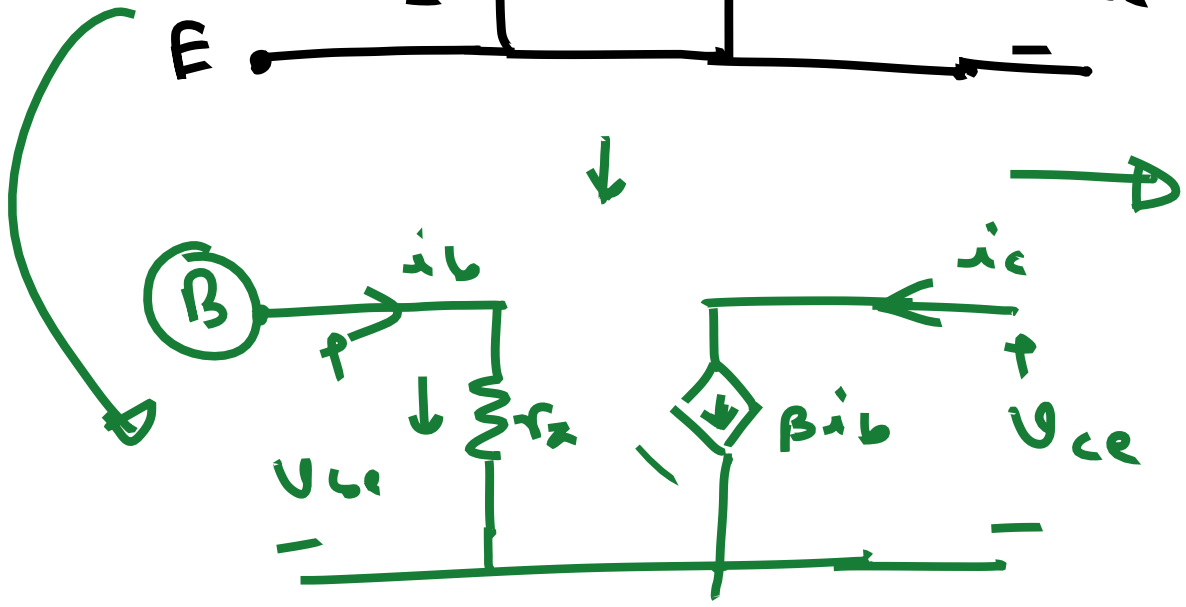


Basic BJT Amplifiers

Small-Signal equivalent circuit of BJT (AC)

Small-signal hybrid-π ckt model.





n-p-n

$$r_x = \frac{\beta V_T}{I_{CQ}}$$

$$g_m = \frac{I_{CQ}}{V_T}$$

Q-point

DC biasing point

$$r_x \times g_m = \beta$$